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THE INTERSTATE AIR POLLUTION STUDY, ST. LOUIS-EAST ST. LOUIS METROPOLITAN AREA

R. A. Venezia

Public Health Service
Washington, D. C.

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THE INTERSTATE AIR POLLUTION STUDY

ST. LOUIS - EAST ST. LOUIS METROPOLITAN AREA

R. A. Venezia
Senior Assistant Sanitary Engineer
U. S. PUBLIC HEALTH SERVICE
DIVISION OF AIR POLLUTION

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INTRODUCTION

Air pollution and air pollution control are not new phenomena in the St. Louis metropolitan area. Smoking stacks at one time were a symbol of prosperity; however, this symbol lost its glamour when people began to recognize its associated problems (Figure 1).

The first recorded antismoke action in St. Louis occurred in 1863 when a damage suit was filed against an individual's smoking chimney. The City's first antismoke ordinance was passed in 1893. Many subsequent attempts to improve the local air quality through ordinances were made, with little success.

Realizing that a new and drastic approach was necessary, if the city was ever to remove the persistent sooty pall that had become commonplace, St. Louis pioneered a new preventive type of antismoke regulation in 1937. This ordinance specified the type and quality of coal that was to be sold in the city. In 1940 further restrictions that limited the use of high-volatile-content coal were passed.

These smoke abatement activities, along with the decline in the use of coal in smaller heating plants and the elimination of some burning refuse dumps, have greatly reduced the black smoke in the air over the area. The gloomy, dirty "Black Fridays" of the 1930's are only a memory of older residents. The U. S. Weather Bureau reported an average overall reduction in smoke of 73 percent from 1939 to 1946.

Many citizens of the St. Louis metropolitan area think their air pollution problems are solved; however, many obvious sources of pollution can still be observed, and much more remains to be done. Visibility is severely decreased on many occasions. Objectionable odors permeate many

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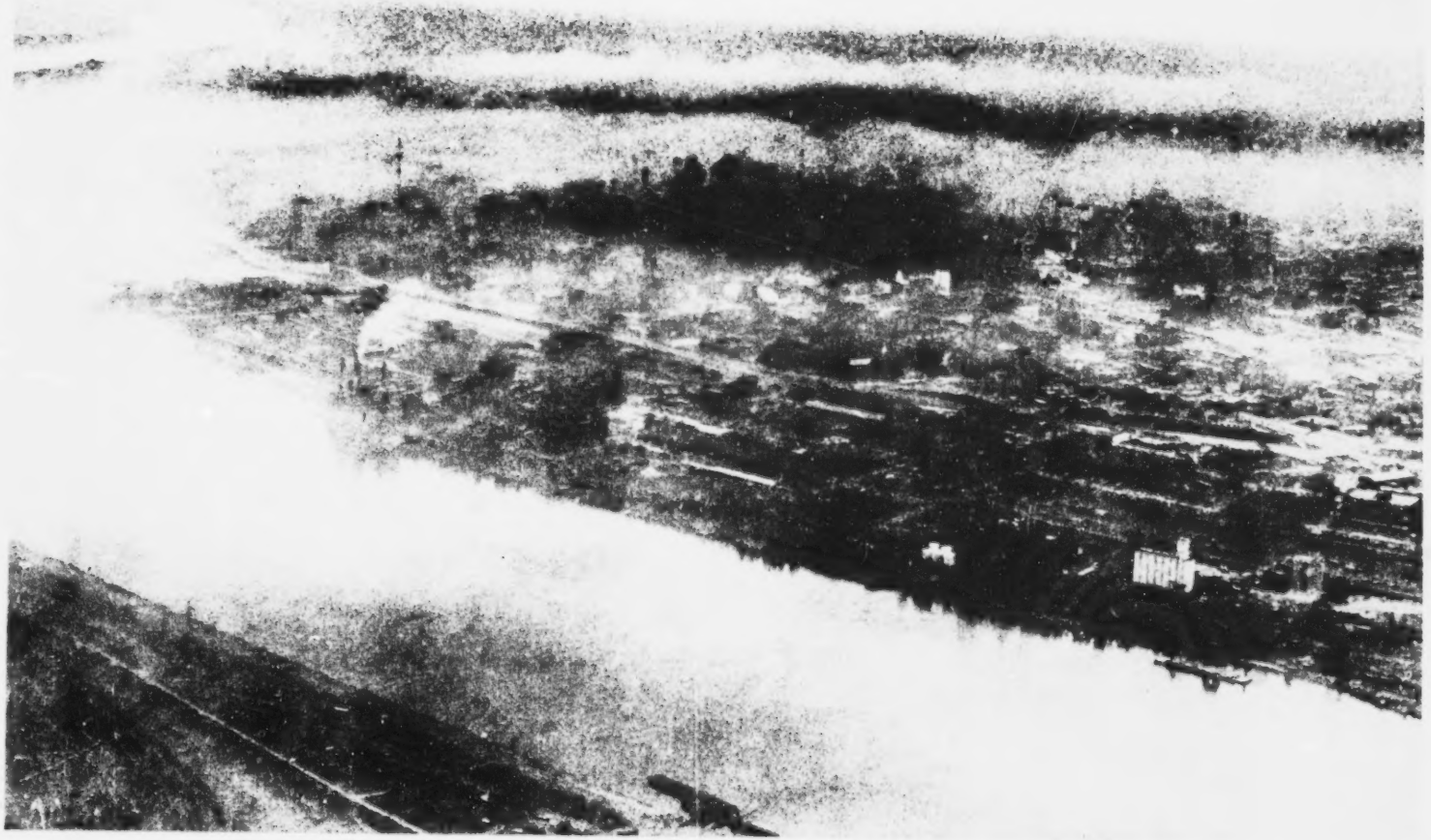

Figure 1. St. Louis, Mo., November 1962.

areas and sometimes spread over great distances. Invisible and odorless contaminant gases are emitted to the atmosphere in great quantities. Some of the gases react in the atmosphere in the presence of sunlight to make new, more objectionable compounds. Respiratory difficulties; eye, nose, throat, and skin irritation; damage and soiling of materials; and damage to flowers, trees, and other plants are among the evidence that excessive air pollution is present.

With the continued increase in population in the St. Louis metropolitan area and the resultant increase of contaminant emissions due to community activities, constructive action is necessary to prevent the atmosphere from becoming increasingly polluted.

The first steps have already been taken with the formation of the Interstate Air Pollution Study. This Study of the St. Louis - East St. Louis metropolitan areas is the result of concern about mutual problems in Missouri and Illinois. In February 1962, simultaneous requests were made to the United States Public Health Service, Division of Air Pollution. The East St. Louis City Air Pollution Commission requested help in preparing an ordinance and in developing an air pollution control program, and the City of St. Louis asked for help in studying an odor problem that affected a large area. It was recognized by all concerned that the problems were not fully contained in the jurisdictions requesting help. For this reason, the Study was organized to cover St. Louis, East St. Louis, and surrounding municipalities and counties (Madison, St. Clair, and Monroe in Illinois, and St. Louis, St. Charles, and Jefferson in Missouri). To direct the Study, an executive committee of representatives of the several cooperating

agencies was formed. These agencies are listed below:

Bi-State Development Agency

St. Louis Department of Health & Hospitals

St. Louis - Division of Air Pollution Control

East St. Louis Air Pollution Control Commission

St. Louis County Health Department

East Side Health District

Missouri Division of Health

Illinois Department of Public Health

Chamber of Commerce of Metropolitan St. Louis

Illinois Air Pollution Control Board

DHEW, Public Health Service

The central project staff consisted of approximately five technical people and one secretary, furnished by the Public Health Service. This staff was supplemented by personnel of local and state agencies and by certain Public Health Service research staff members. The findings of the various studies are related by means of a map grid coordinate system. An automatic data-processing system allows ready search for correlation between any of the items studied on any time, geographic, or subject matter relationship. In keeping with the air resource management concept, there has been a considerable variety of subjects examined, although some of them not to the degree they warrant, because of lack of funds, personnel, or time.

AIR RESOURCE MANAGEMENT

The essential component of this concept is the application of scientific methods to the use and conservation of air resources of an air pollution basin for the advancement and benefit of the human resources. The term "air pollution basin" as used here refers to an area in which air contaminants originate and collect, and in which the principal effects of

those contaminants occur. Further examination of this concept needs to be accomplished in great detail. The major air resource management program areas, however, are clear. They are:

1. A continuing air quality monitoring program.

   For a sound basis upon which to build a strong program, the quantity and type of contaminants in the atmosphere must be known. This does not mean that any given contaminant measurements should be made indefinitely, but that a comprehensive program be set up to insure periodic followups of selected contaminants measured so that the most value is obtained for the time and money spent on air quality measurements.

2. A current and continuing air contaminant emission inventory.

   An air contaminant emission inventory is a systematic survey of sources of air pollution, taken to determine the amount of air contaminants released to a given air mass. Emissions from a particular source are generally related to ground-level concentrations near that source, but many other considerations, such as topography and meteorology, must be considered. For example, totals of air contaminant emissions in their several types could be ascertained. The geographic distribution of these emissions could be determined and various air quality level predictions, based upon meteorological conditions and the emission situation, could be made.

3. Air quality goals, standards, and criteria.

   Goals relate to objectives that are not necessarily legal standards, nor need they be linked to only obvious health

effects or vegetation damage. They should relate to what is best for the development of the human resources of the community. Standards relate to those items that are specified by law. They may be as broad in their meaning as goals or they may be limited, having to do specifically with some health effect or some vegetation damage effect. Criteria refer to relationships of air quality and various effects of pollution; word meanings equated with numerical values.

Air quality goals or standards should assure, with a reasonable factor of safety, air that will not cause health hazards and, in addition, should provide for meeting the desires and capability of the community to obtain and support cleaner air within the limits of technical and economic feasibility.

4. A thorough knowledge and use of the conditions influencing the transport of air contaminants.

The transport of air pollution in any small area is related to meteorological conditions. Study and understanding of meteorology is not only important for controlling air pollution, but is also important in other aspects of community development.

5. Urban planning decisions based on air quality as well as other environmental factors.

The considerations of land use, such as residential, commercial, and industrial purposes, in relation to air quality levels, could lead to the establishment or revision of air quality goals, standards, criteria, zoning decisions, and community planning decisions, and would assist with the orderly development of the community.

6. Air pollution control decisions and resulting ordinances based upon information and scientific determinations made regarding air quality.

To reach realistic decisions and adequate ordinances requires a thorough knowledge of the scientific parameters involved.

In Figure 2 a representation of an air resource management program is depicted.

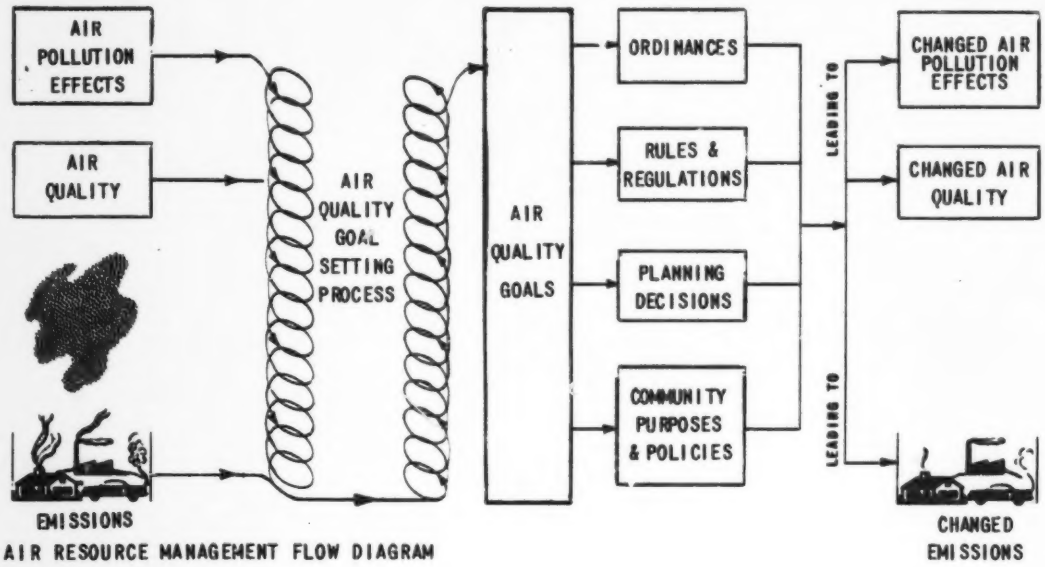

Figure 2. Air resource management flow diagram.

The prominent position of "air quality goals" in the center of Figure 2 is indicative of the importance attached to this particular feature. The items that go into the establishment of the goals are the air pollutant emissions, the dispersion of air pollutants, existing air pollution levels, the effects that air pollution levels cause, cost of control, and public convenience. All of this considered within a suitable decision-making process leads to the establishment of goals, which in turn leads to different ordinances,

rules and regulations, planning decisions, and community purposes and policies. Institution of the new code and public outlook then lead to changes in emissions, changed pollution levels, and changes in the effects of the pollutants.

STUDY PROGRAM

The following list illustrates the type and variety of activities carried out during the Interstate Study:

1. Air quality levels as indicated by:

   a. Dustfall. Dustfall was measured by exposing open buckets for 1-month periods, after which both the soluble and insoluble particulates were measured. A total of 41 stations made up the sampling network (Figure 3). The stations also contained equipment for corrosion and sulfation determinations.

      The geometric mean for dustfall for the period March 1963 through February 1964 was 18.4 tons per square mile per month. The highest levels occurred in March, 29.1 tons/mi^2/mo; the lowest levels were measured in December, 12.1 tons/mi^2/mo. The seasonal levels followed the same pattern, with spring high and winter low.

   b. Suspended Particulates (total weight). Suspended particulates were measured with a Hi-Vol air sampler (Figure 4). Sixteen of these samplers were operated during the survey period. During the period from July 1963 through June 1964, geometric mean fall and winter values of 119.2 and 105.0 $\mu g/m^3$, respectively, were found, based on a daily weekday sampling

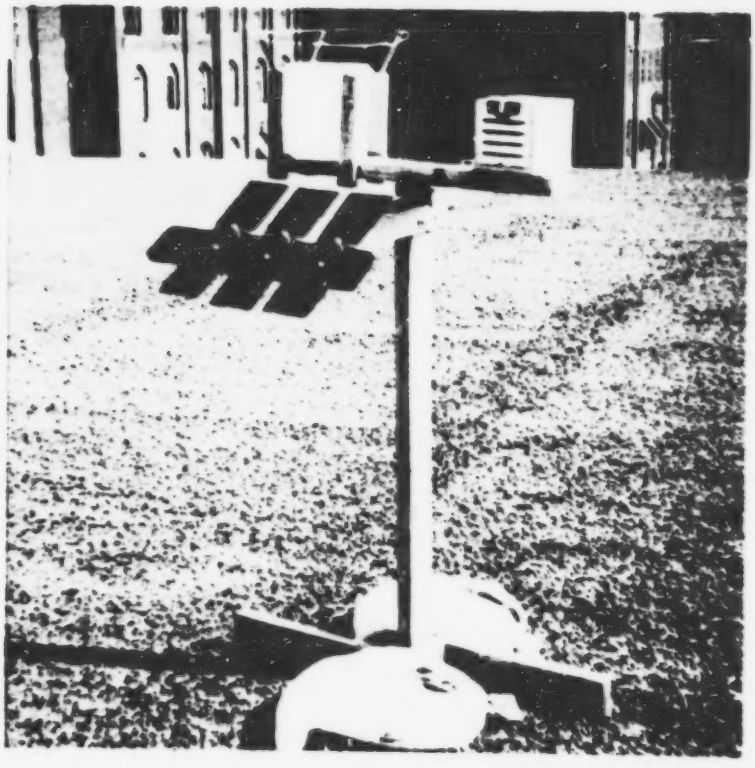

Figure 3. Dustfall bucket with metal corrosion panels and sulfation candle.

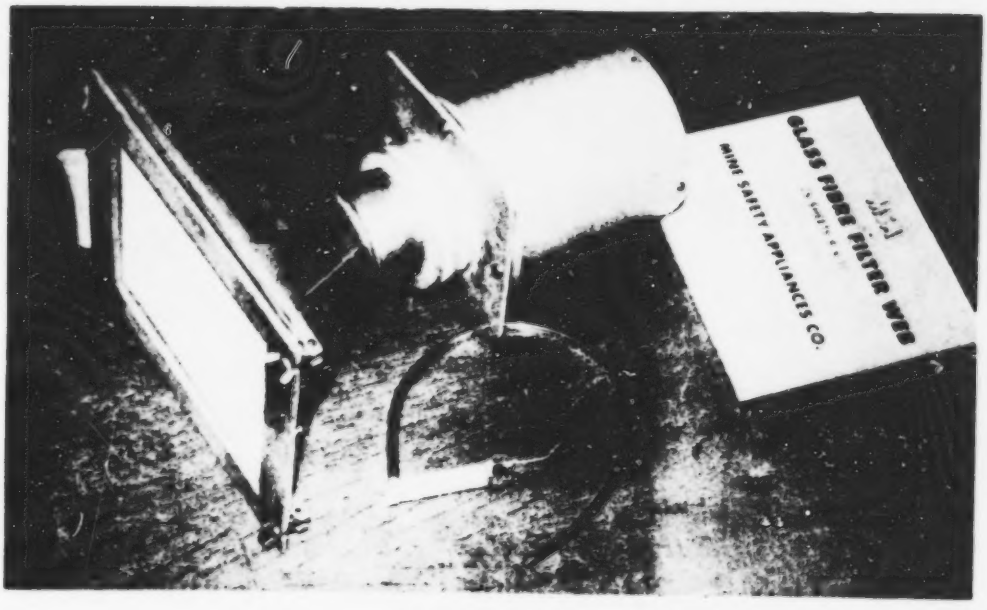

Figure 4. Hi-Vol air sampler.

schedule. To calculate geometric mean values for the year, samples were selected on a random basis to prevent statistical bias. Using this system, the following geometric means were obtained: Spring 100.1, summer 98.6, fall 105.5, winter 91.8, and annual 98.8 $\mu g/m^3$. In view of the approximate 14 $\mu g/m^3$ difference between the daily sampling schedule and the fall and winter random sampling schedule results, it appears that random sampling in this case selected values in the lower portion of the expected range.

c. Soiling Index. A 12-station AISI tape sampler network was used to determine the soiling index (Figure 5). This instrument collects a sample every 2 hours on a continuous basis. The sample is evaluated by shining light through it. The percent transmitted is the basis for calculating a Coh, coefficient of haze, per 1000 lineal feet. Data from this network have not been fully evaluated.

d. Sulfur Dioxide (as measured by volumetric methods). Two types of samplers were used to determine sulfur dioxide. Two-hour sequential samplers were operated at four locations for approximately 1 year during 1963-64 (Figure 6). Operating problems made the data collected incomplete and of questionable value. Ten modified samplers were operated continuously 24 hours a day from December 1964 through February 1965, as part of the SO_2 monitoring program (Figure 7). These data, which are being processed, are 2-hour samples.

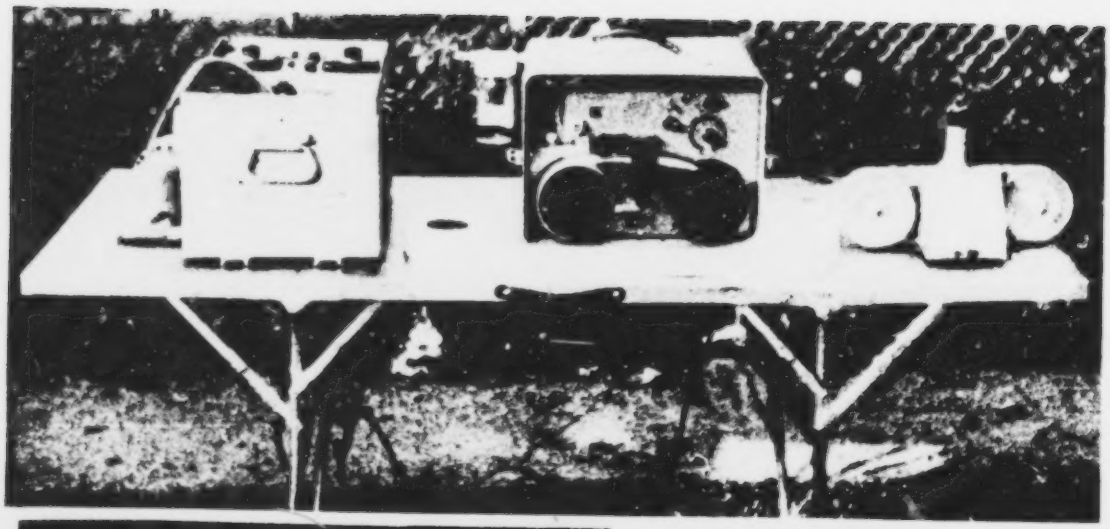

Figure 5. (L to R)
Sequential sampler,
AISI tape sampler,
AISI tape reader.

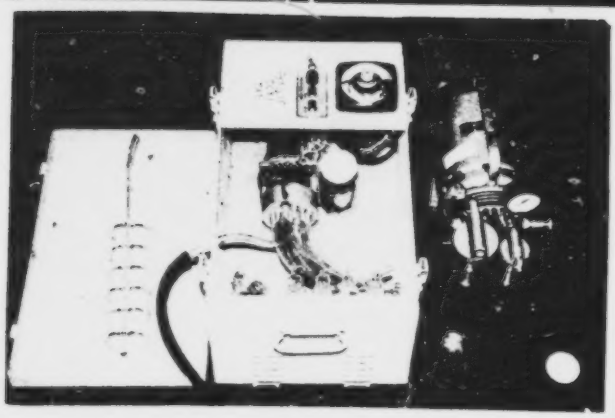

Figure 6. Two-hour sequential sampler.

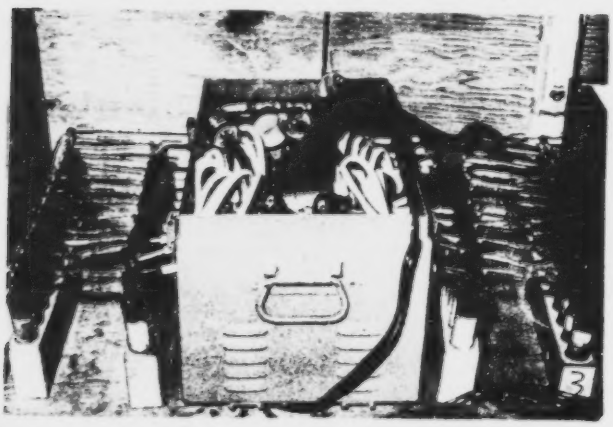

Figure 7. Modified 2-hour sequential sampler.

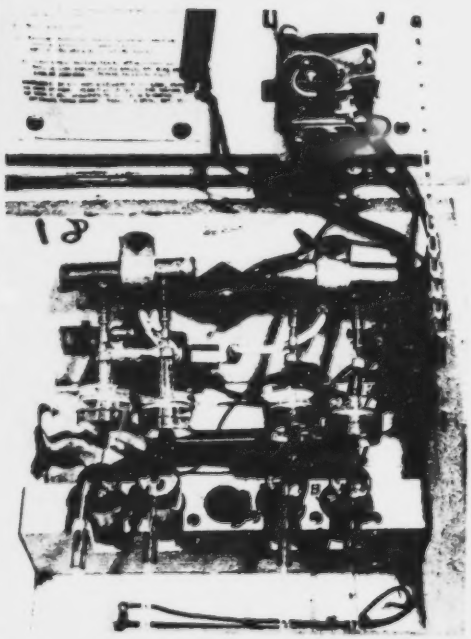

Figure 8. 24-hour composite gas sampler.

The second volumetric SO_2 sampler collected a 24-hour composite (Figure 8). In the 1963-64 study only 20 samplers were used. The data for the period December 1, 1963, through February 29, 1964, show winter seasonal mean SO_2 concentrations ranging from a high of 0.042 ppm to a low of 0.005 ppm. For the winter study of 1964-65 a total of 40 samplers were used. These data are being processed.

e. Sulfur Dioxide (as measured by the lead peroxide method). A lead peroxide candle is in reality a jar wrapped with gauze impregnated with lead peroxide paste (Figure 9). Most atmospheric sulfur compounds are converted by the peroxide to a sulfate, which is interpreted as a sulfation value in milligrams sulfur trioxide per 100 square centimeters of gauze area per day. The largest part of the reaction is caused by sulfur dioxide in the atmosphere, but other sulfur compounds also react. The primary use of sulfation information is to show geographical distribution.

Geometric means for 41 locations from February 20, 1963, to February 10, 1964, range from a high of 5.26 to a low of 0.22 milligrams $SO_3/100\ cm^2/day$. A 30-to-47 station network operated from March 1963 through February 1964; the winter mean was highest, 1.33 $mg/100\ cm^2/day$, and the summer was lowest, 0.659 $mg/100\ cm^2/day$.

f. Oxidants. An 8-station oxidant network was operated from May 15 through October 21, 1964. One of the instruments,

which was designed for the St. Louis Study, determined that oxidant levels in the eye-irritation range do occur occasionally (Figure 10).

g. Odors. Three odor surveys were made in connection with the project. The first was a small-scale, stationary-observer study covering the south St. Louis City area. The second was a moving-observer study covering the entire City of St. Louis. The third was similar to the first, but also included St. Louis County, Missouri, and St. Clair County, Illinois. In surveys one and two, 510 odor observations were made; 200, or 39 percent indicated presence of odors in the ambient air.

The third survey was conducted during the 2-week period November 18 through December 1, 1963. Five odor observations were made each day at 79 observation sites.

St. Louis City was found to have the highest frequency of odors detected; Illinois was second; and St. Louis County was third. Odors were detected in 29.6 percent of all observations. Odors were detected most frequently during the evening hours, and decreased after 8 p.m. The Illinois area did not follow this pattern. For St. Louis City and St. Louis County, easterly wind directions were associated with a greater number of odor detections. The two most frequently detected odor types were combustion and combustible waste (Figure 11). Chemical odors were the third most common odor type detected in the metropolitan area,

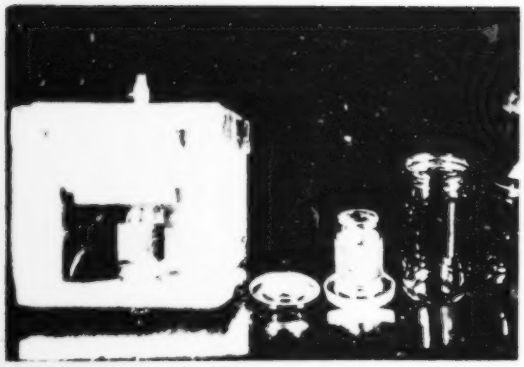

Figure 9. Lead peroxide candle and shelter.

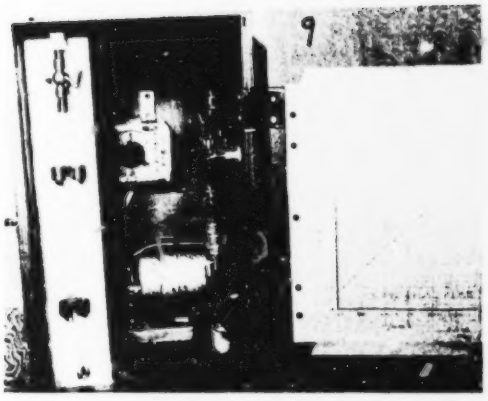

Figure 10. Oxidant sampler.

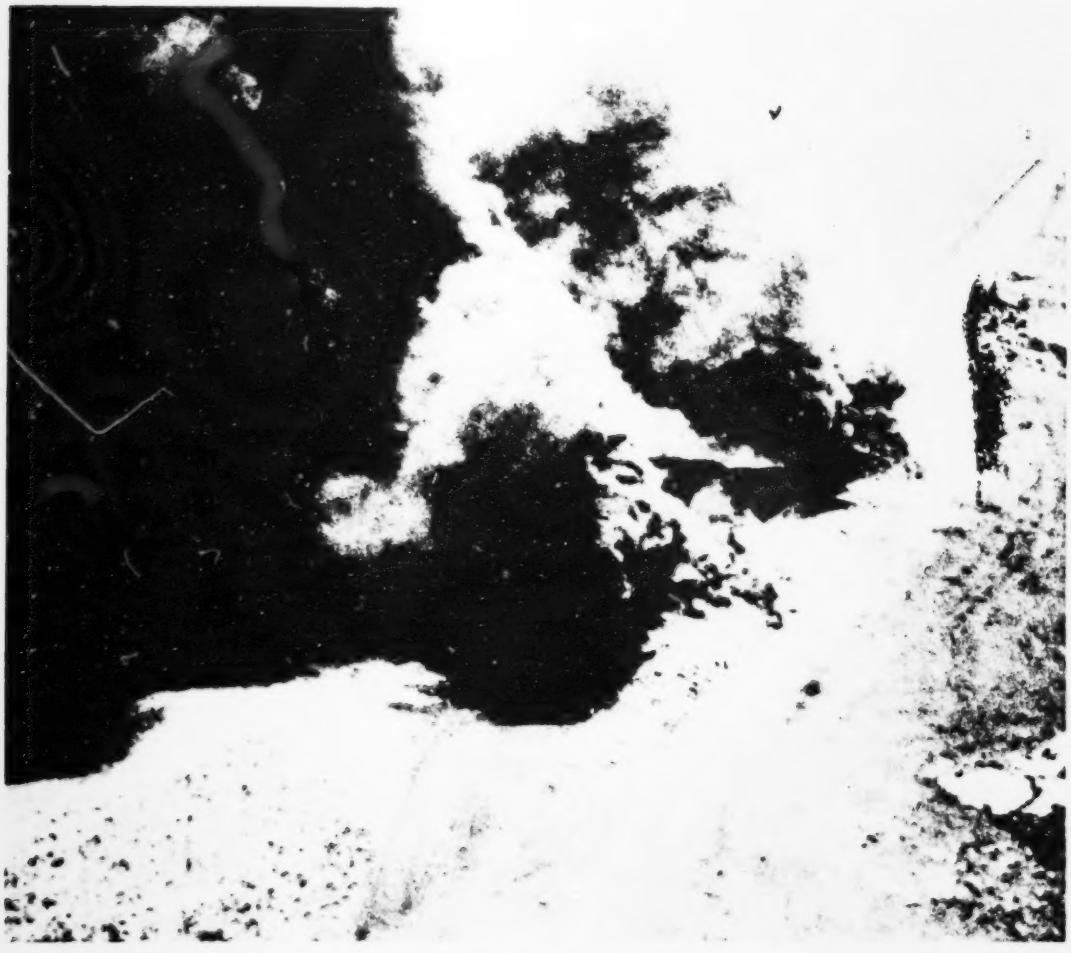

Figure 11. Combustible waste burning.

and the second most frequently detected odor in St. Louis City. One major odor episode was observed during the survey. It originated in Illinois and was detected to a distance of 12 miles.

h. Continuous Air Monitoring. In February 1964, a continuous air monitoring station was installed in downtown St. Louis to become a part of the nationwide monitoring program of the Public Health Service (Figure 12). This station continuously measures and records concentrations of carbon monoxide, total hydrocarbons, nitrogen oxide, nitrogen dioxide, sulfur dioxide, ozone, total oxidants, and particulates.

i. Atmospheric Turbidity. Atmospheric turbidity was measured by a sun photometer to the east and southwest from downtown St. Louis (Figure 13). For the year June 1963 through May 1964, visibility to the east was consistently less than that to the southwest. Visibility of less than 3 miles to the east occurred 43.5 percent of the time when the relative humidity was less than 70 percent, while the same visibility reduction in the southwest direction occurred only 18.6 percent of the time.

2. Air Pollution Effects as indicated by:

a. Metal Corrosion. The amount of corrosion experienced on steel panels was measured in different parts of the project area. The values, determined by weight loss in grams per 4- by 6-inch panel for the period April through November 1963, represent a direct relationship to the

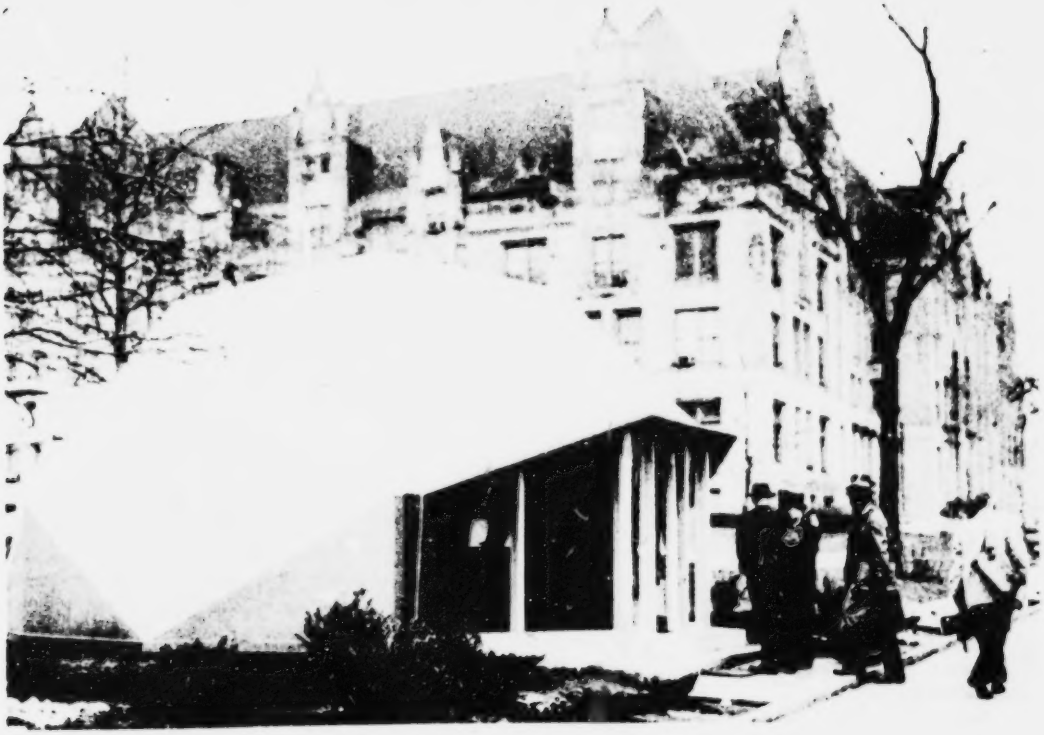

Figure 12. Continuous air monitoring program station, St. Louis, Mo.

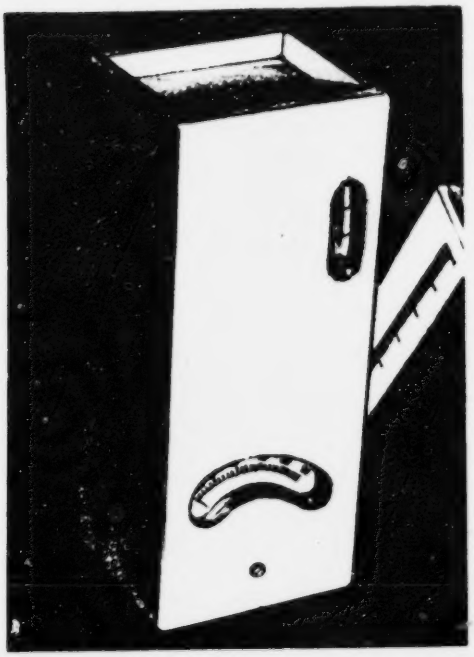

Figure 13. Sun photometer.

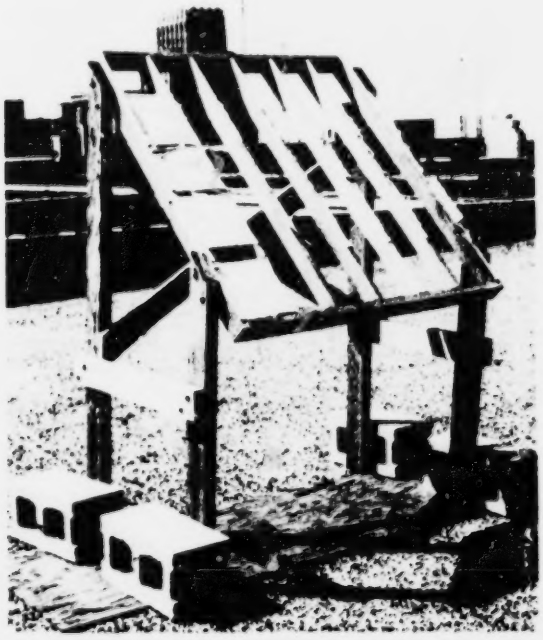

Figure 14. Cotton exposure rack.

corrosiveness of the atmosphere.

b. Cloth Deterioration. Loss of strength of exposed samples of nylon and cotton were determined. Nylon panels were exposed on Hi-Vol samplers, and cotton on a cotton exposure rack (Figure 14).

c. Health. An investigation is under way in some of the major hospitals in the St. Louis area to determine whether a pattern of increased emergency room visits due to asthma exists and, if it does, to interpret its meaning with respect to air contaminant values.

d. Opinion Surveys. Two surveys were made. A public opinion survey involving 1000 interviews was carried out jointly by the National Opinion Research Center of the University of Chicago and Southern Illinois University at Edwardsville, Illinois.

Questionnaires were sent to officials of 141 cities and other incorporated communities in the Study area. Almost all officials indicated that they received air pollution complaints, but over half of the respondents indicated they believed that no air pollution problem existed in their area of jurisdiction, or that if it did it was minor.

e. Complaint Records. Records of 4,584 complaints made to local agencies from 1958 through 1962 were analyzed to determine the nature of air pollution problems. Odor complaints outranked the next highest by almost 4 to 1.

3. Air Pollutant Emission Inventory.

The emission inventory was defined previously. Road vehicles accounted for approximately 94 percent of the carbon monoxide and 36 percent of hydrocarbon emissions. Industrial fuel use and process emissions accounted for approximately 50 percent of the particulate emissions (Figure 15). Electric utility generating plants accounted for approximately 55 percent of the sulfur dioxide and 47 percent of the nitrogen oxides emitted. Other sources considered are: Residential and other types of fuel use, solid waste disposal, solvent evaporation, railroads, aircraft, and river vessels.

4. Meteorology and Climatology.

A study was made of the meteorology and climatology of the area.

5. Tracer Diffusion.

Fluorescent particles were used to determine atmospheric flow patterns over an urban area (Figure 16). These particles were zinc cadmium sulphide, which were released and collected by three different types of samplers.

6. Mathematical Atmospheric Models.

Diffusion models are being developed. They will be tested by the atmospheric SO_2 sampling carried out this past winter season.

7. Economic Losses From Air Pollution (Figures 17 and 18).

An investigation was conducted by staff members of Washington University, St. Louis, Missouri, to determine economic losses caused by air pollution. A report on this subject is forthcoming.

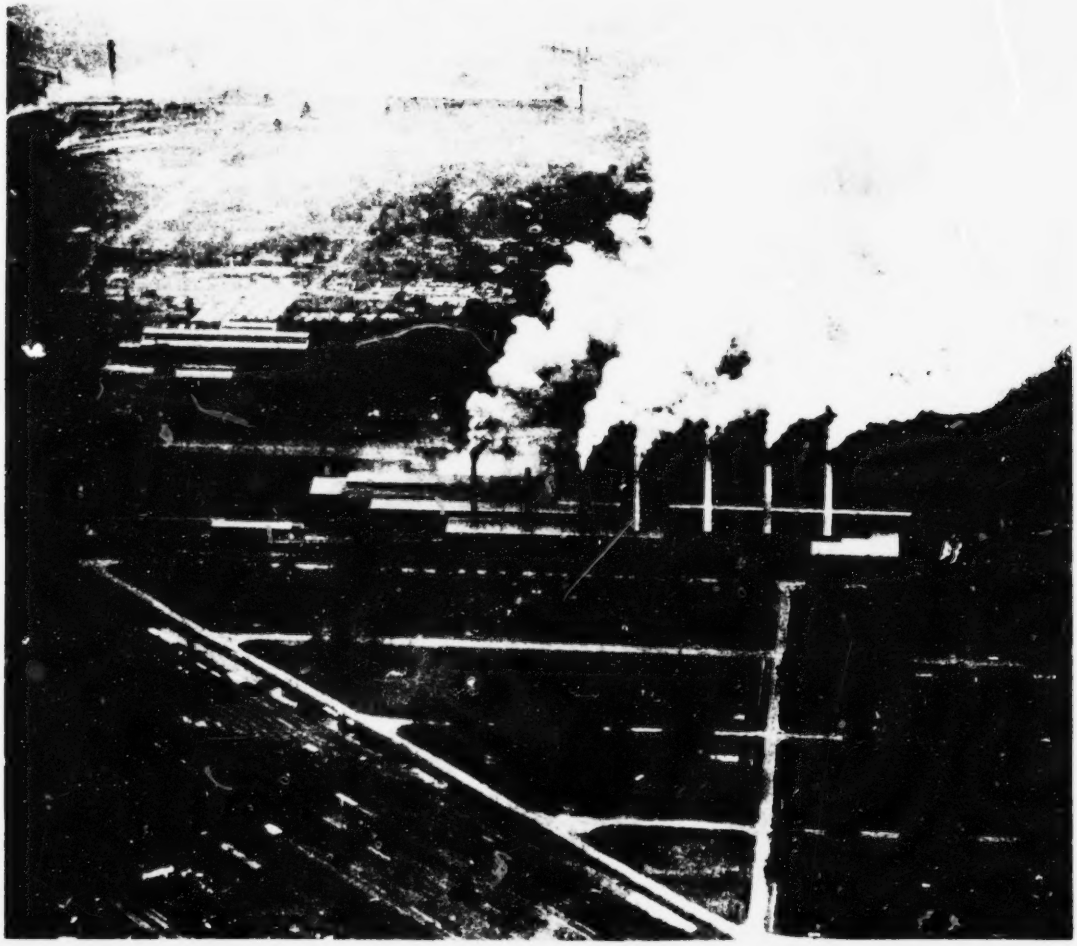

Figure 15. Industrial emissions.

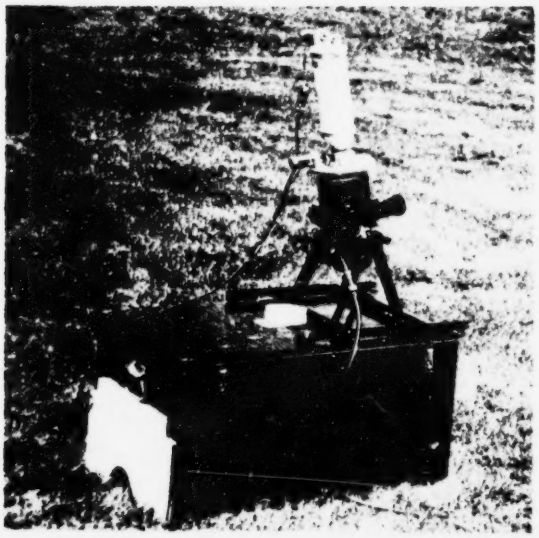

Figure 16. Fluorescent particle disseminator.

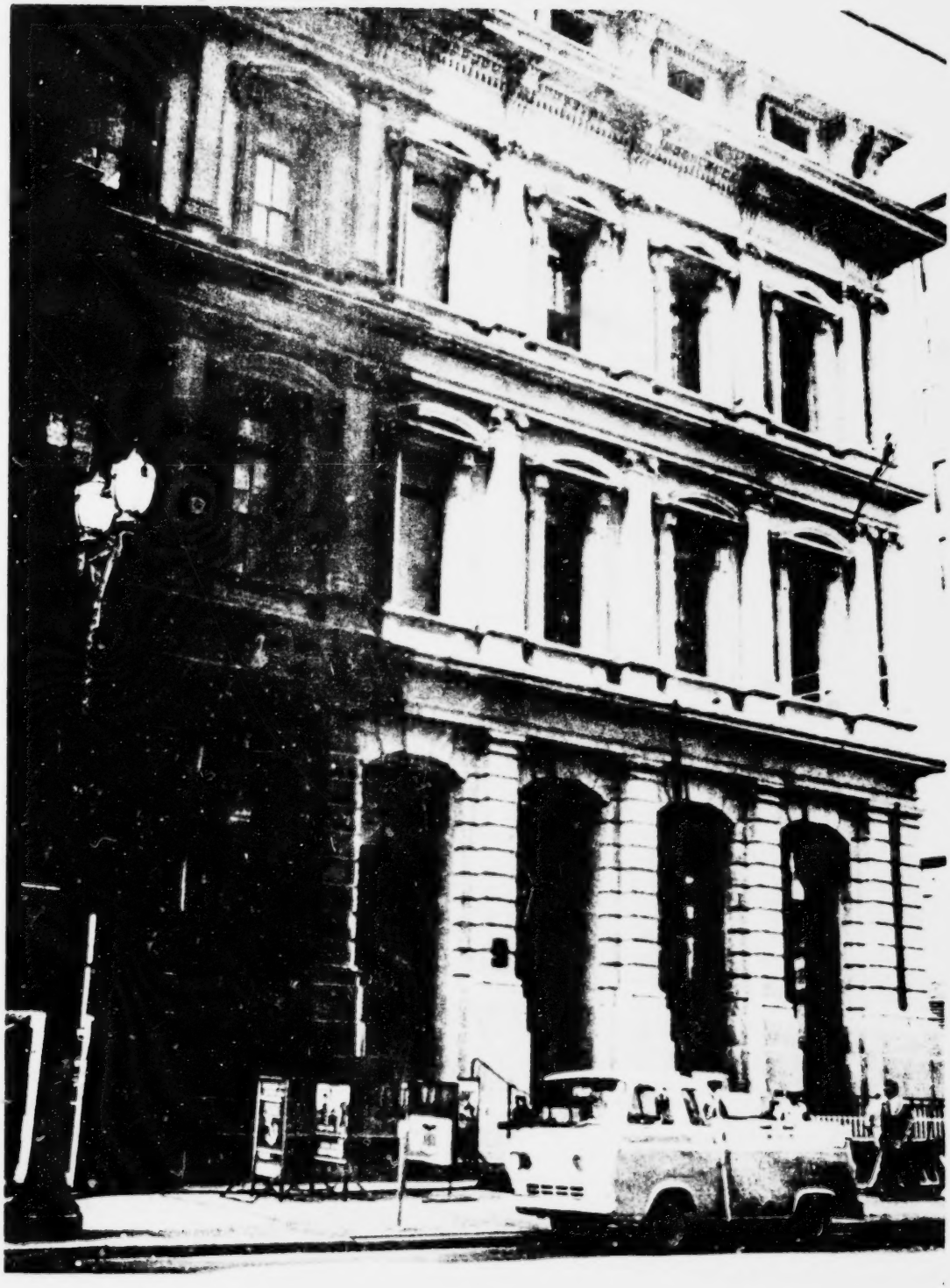

Figure 17. Cleaning of Old Post Office Building, St. Louis, Mo.

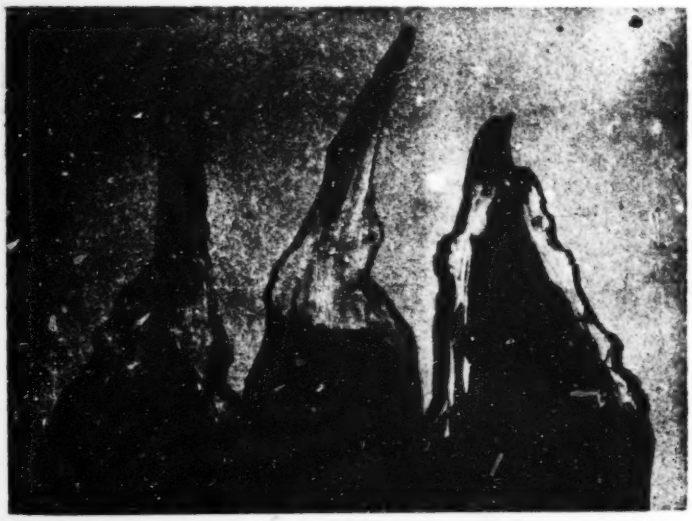

Figure 18. Sulfur dioxide injury to tulips.

Figure 19. Cleaner Air Week activity in St. Louis, Mo.

8. Laws and Ordinances.

   Existing local air pollution ordinances and control programs do not cover the area with any reasonable degree of completeness or uniformity. Although noteworthy advances have been made in the preparation of local ordinances, a major gap still exists in defining the relationship between the two states and between local autonomous juristictions.

9. Public Relations Programs.

   An active public relations program is being conducted (Figure 19).

Certain of the Study items are primarily research, while others emphasize local program needs. In all cases they supplement each other and are used to the fullest extent possible in developing a suitable metropolitan area air resource management program covering the two-state, six-county, 150-city area of 2 million people.

In summary, air resource management is simply a program directed toward obtaining the highest beneficial use of the limited air resource in which we live and work, while maintaining a reasonable degree of air purity necessary for protecting the health, welfare, and property of the people.

Whatever other uses man may devise for it, air is still essential for breathing and must be kept clean enough to serve that primary purpose.